

## Methods and data processing report for $^{234}\text{Th}$ survey during EXPORTSNP

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### Brief protocol description

We used the particle-reactive tracer, thorium-234 (half-life = 24.1 d) to quantify the spatio-temporal variability in particle flux from the well-lit surface layer, and its attenuation with depth below. The disequilibrium in  $^{234}\text{Th}$  from its soluble parent, uranium-238, provides quantitative information on where particle export and remineralization occurs. The link from  $^{234}\text{Th}$  to carbon or other elemental fluxes is based upon determining the ratio of particulate  $^{234}\text{Th}$  to C (done also for inorganic C, nitrogen, biogenic silica and phosphorus) measured on depth resolved profiles of size-fractionated particles (>1 to 50-100  $\mu\text{m}$  range) collected using in-situ pumps (see EXPORTS\_EXPORTSNP\_size-fractionated\_particles\_in\_situ\_pumps\_report.pdf). The fluxes derived from this approach include all of the sinking particle pathways, as well as net removal of surface ocean particles (EXPORTS pathways 1, 2, 3), if removed by diel migrating zooplankton and released after they return to depth (pathway 5). We present results from over 850 measurements of  $^{234}\text{Th}$  as part of the first NASA supported EXPORTS cruise in the NE Atlantic at Ocean Station PAPA. Additional  $^{234}\text{Th}$  data was collected two weeks later as part of the Canadian Line P program (Roger François and William J. Burt, University of British Columbia).

### Sample analysis

Total  $^{234}\text{Th}$  activities were determined from two-liter samples following the  $\text{MnO}_2$  co-precipitation technique (Benitez-Nelson et al., 2001, Buesseler et al., 2001) using  $^{230}\text{Th}$  as a chemical yield tracer. The precipitates were filtered through QMA filters (25 mm), which were dried and counted aboard using low-background beta multi-counter systems (Risø National Laboratory, Denmark). Samples were recounted six months later at WHOI to determine the background activity of high-energy beta emitters. Filters were then processed to determine  $^{230}\text{Th}$  by ICP-MS using  $^{229}\text{Th}$  as an internal standard (Pike et al., 2005). Each  $^{234}\text{Th}$  measurement includes an associated analytical counting uncertainty. The activity of  $^{238}\text{U}$  was derived from salinity using the relationship given by Owens et al. (2011).

### Key analytical method references

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